

4 Vegetation Protection, Reforestation, and Maintenance

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Mature native vegetation and soil are necessary to maintain watershed hydrology, stable stream channels, wetland hydroperiods, and healthy aquatic systems (Booth et al., 2002). While necessary to maintain aquatic systems, native vegetation and soils are also the most cost-effective and efficient tools for managing stormwater quantity and quality. Hydrologic modeling comparing conventional development and low impact development (LID) designs suggests that of the various LID applications, reducing the development envelope and increasing vegetation and soil conservation areas can provide the single largest reduction of storm flows (Table 4.1) (AHBL, 2002).

Table 4.1 Hydrologic modeling comparing a conventional development and the flow reduction benefits from individual practices for a low impact development design. The 24-acre till-mantled site in southern Puget Sound has 103 lots and was modeled with the Western Washington Hydrologic Model (adapted from AHBL, 2000).

	Detention storage reduced (ft ³)	Detention storage required (ft ³)
Conventional development	0	270,000
Low impact development		
Reduce development envelope, 24' wide road	- 149,019	
And use bioretention swales and cells	- 40,061	
And use minimal excavation foundations	- 7,432	
And use 20' wide permeable paving road	<u>-29,988</u>	
Total	-226,500	43,500

Retaining native soil and vegetation protection areas is a primary objective for low impact development in order to: (1) reduce total impervious surface coverage; (2) provide infiltration areas for overland flows generated in adjacent developed portions of the project; and (3) maintain or more closely mimic the natural hydrologic function of the site. The protection areas provide additional benefits, including critical area and habitat protection, open space corridors for passive recreation, visual buffers, and erosion and sediment control.

Objectives for on-site native vegetation coverage:

- Rural and large lot development: 65 percent minimum.
- Medium density (4 to 6 dwelling units per acre): 50 percent minimum.

While necessary to maintain aquatic systems, native vegetation and soils are also the most cost-effective and efficient tools for managing stormwater quantity and quality.

- High density (more than 6 dwelling units per acre): protect or restore to the greatest extent practical. Note: in medium to high density settings, reducing the development envelope and protecting native forest and soil areas will often require multifamily, condominium, cottage or mixed attached and detached single family homes (see Chapter 3: Site Planning and Layout).
- Riparian Management Areas can be included as a part of the native vegetation retention area and are the highest priority for native vegetation retention.

The 65 percent forest retention objective is a watershed level target based on best available science for maintaining watershed hydrologic functions (Booth et. al, 2002). Not all projects can achieve 65 percent protection at the project site. However, projects attaining 40, 50 or 60 percent native vegetation protection and using a full complement of LID practices still play a critical role in achieving overall watershed protection objectives when part of a larger planning process that strategically conserves riparian and other sensitive resources at a regional scale.

The following sections provide guidelines for native vegetation protection during the construction phase, enhancement or rehabilitation of impacted areas, and strategies for long-term maintenance.

4.1 Native Vegetation Protection

Native vegetation and soil protection areas in today's urban, suburban, and rural settings are fragments of pre-European contact forests and prairie. Natural successional forces have been altered and active management is required to compensate for the loss of natural processes and the addition of new stressors (Matheny and Clark, 1998). Vegetation protection areas not directly adjacent to structures (or located where they may potentially impact a structure) should be managed to encourage natural successional patterns and develop diverse multilayer canopy structure, snags, large woody debris, understory vegetation, and forest duff. The protection, reforestation, and management strategies provided below are designed to maintain vegetation cover, adequate soil building, and plant regeneration processes necessary for retaining these areas for the long term.

Assessment of natural resources and the site planning process will identify and delineate critical areas and native vegetation offering the best suite of benefits, including greatest infiltration potential. The final delineation and details of the management program for the vegetation protection areas requires assessment by a qualified urban forester or landscape architect that considers size of the area, type of soil, exposure, vegetation type and structure, invasive species impacts, human use, condition of existing vegetation, and existing and post-development hydrologic patterns in the area.

Selection of dispersed individual trees and tracks of native vegetation may be necessary to meet native forest and soil protection objectives. Individual trees selected for protection should have developed as individuals with well-tapered trunks and good live crown ratios (total tree height in relation to the height of the live crown). Trees from dense stands with tall, poorly tapered trunks and high irregular shaped crowns generally do not adapt to wind and sun exposure and are not good candidates to preserve as single trees (Figure 4.1) (Matheny and Clark, 1998). As a general guideline, conifers with live crown ratios of less than 30 percent tend to break in winds while trees with ratios greater than 50 percent tend to be more stable (Matheny and Clark, 1998).

LID in Green Cove Basin

To protect sensitive aquatic resources, the city of Olympia requires all development in the Green Cove basin to have approximately 55 percent tree cover.



Figure 4.1 These native trees that were retained during clearing have low live crown ratios.

Photo by Curtis Hinman

Trees and other native vegetation that developed in forests or woodlands are best retained in groups of sufficient size to maintain adequate growing space characteristics and the integrity of the unit. Growing space characteristics include soil moisture, sunlight, humidity, wind, competition among adjacent plants, and other growth factors. Retaining small fragments of mature, single species trees adapted to the interior of a forest stand is seldom successful (Matheny and Clark, 1998). Additional stressors along newly exposed edges of larger preserved vegetation tracts can affect unit integrity and result in high initial plant mortality on the perimeter. Replacement of unhealthy trees and other vegetation with material adapted to edge environments, as well as invasive species control, may be necessary (Matheny and Clark, 1998).

Delineation and management of larger tracts and smaller scale, dispersed protection areas are necessary to meet retention objectives on most sites. Larger contiguous tracts are more likely to sustain healthy soils, retain diverse and dense vegetation coverage, and have less area affected by edge stress factors (increased sunlight, wind, and invasive species). Small-scale dispersed protection areas can be located to intercept storm flows at the source, reduce flow volumes within small contributing areas, and maintain time of concentration. Specific site and design requirements will influence the type and distribution of protection areas; however, the location and type of area can influence the extent of benefit and long-term viability.

The following provides a list of native vegetation and soil protection areas prioritized by location and type of area:

1. Large tracts of riparian areas that connect and create contiguous riparian protection areas.
2. Large tracts of critical and wildlife habitat area that connect and create contiguous protection areas.
3. Tracts that create common open space areas among and/or within developed sites.
4. Protection areas on individual lots that connect to areas on adjacent lots or common protection areas.
5. Protection areas on individual lots.

4.1.1 Protection During the Construction Phase

Soil compaction is a leading cause of death or decline of mature trees in developed areas (World Forestry Center, 1989). Most tree roots are located within 3 feet of the ground surface and the majority of the fine roots active in water and nutrient absorption are within 18 inches. Root systems can extend 2 to 3 times beyond the

Soil compaction is a leading cause of death or decline of mature trees in developed areas.

diameter of the crown (World Forestry Center and Morgan, 1993 and Matheny and Clark, 1998). Equipment activity on construction sites can severely compact soil, essentially eliminating soil pore structure at 6 to 8 inches below the ground surface. Compaction can extend as deep as 3 feet depending on soil type, soil moisture, and total axle load of the equipment. Foot traffic can exert per unit area pressure similar to that of a

vehicle and significantly compact soil as well (Corish, 1995 and World Forestry Center and Morgan, 1989). Soil compaction results in a reduction of soil oxygen and an increase in **soil bulk density**. In response to soil compaction, tree root penetration, root respiration, and associated uptake of nutrients and minerals decline, **mycorrhizal** activity is reduced, and susceptibility to root disease increases (Matheny and Clark, 1998).

Several other direct and indirect impacts can influence vegetation health during land development including:

- Direct loss of roots from trenching, foundation construction, and other grade changes.
- Application of fill material that can compact soil, reduce oxygen levels in existing grade, and change soil chemistry.
- Damage to trunks or branches from construction equipment and activities.
- Exposure of forest interior areas to new stresses of forest edges as land is cleared.
- Changes in surface and subsurface water flow patterns.

Detrimental impacts to native vegetation and soil protection areas can be minimized through the following strategies:

- Map native soil and vegetation protection areas on all plans and delineate these areas on the site with appropriate fencing to protect soils and vegetation from construction damage. Fencing for forest protection areas should be located at a minimum of 3 feet beyond the existing tree canopy along the outer edge of the tree stand. Fencing should provide a strong physical and visual barrier of high strength plastic or metal and be a minimum of 3 to 4 feet high (see Ecology 2005 SMMWW BMP C103 and C104). Silt fencing, or preferably a compost berm, is necessary in addition to, or incorporated with, the barrier for erosion control.
- Install signs to identify and explain the use and management of the natural resource protection areas.
- Meet and walk property with equipment operators to clarify construction boundaries and limits of disturbance.
- Protect drainage areas during construction. Channel or drainage swales that provide a hydrologic connection to vegetation protection area(s) should be protected throughout the construction phase by fencing and erosion control measures to prevent untreated construction site runoff from entering the channel.

- Protect trees and tree root systems utilizing the following methods:
 - o Minimize soil compaction by protecting critical tree root zones. The network of shallow tree roots, active in nutrient and water uptake, extends beyond the **tree canopy dripline**. Several methods can be used to assess the area necessary to protect tree roots. The dripline method may be applicable for broad-canopy trees; however, this method will likely underestimate the extent of roots and lead to extensive root damage for narrow-canopied trees and leaning trees with canopies extending to one side more than the other. As a general guideline, the trunk diameter method provides more design flexibility for variable growth patterns. This method provides a protection area with a 1-foot radius for every 1 inch of trunk diameter at chest height (DBH ~ 4.5ft). Factors that influence the specific distance calculated include the tree's tolerance to disturbance, age, and vigor (Matheny and Clark, 1998).
 - o Limit to an absolute minimum any excavation within the critical root zone. Tree species and soils will influence the ability of a tree to withstand disturbance. If the tree(s) are to be preserved and excavation in the critical root zone is unavoidable, consult a certified arborist for recommendations.
 - o Prohibit the stockpiling or disposal of excavated or construction materials in the vegetation retention areas to prevent contaminants from damaging vegetation and soils.
 - o Avoid excavation or changing the grade near trees that have been designated for protection. If the grade level around a tree is to be raised, a retaining wall (preferably with a discontinuous foundation to minimize excavation) should be constructed around the tree. The diameter of the wall should be at least equal to the diameter of the tree canopy plus five feet. If fill is not structural, compact soil to a minimum (usually 85 percent proctor) (World Forestry Center and Morgan, 1993). Some trees can tolerate limited fill if proper soils and application methods are used. Subsoil irrigation may be required. Consult a certified arborist for recommendations.
 - o Tree root systems tend to tangle and fuse among adjacent trees. Trees or woody vegetation that will be removed and that are next to preserved trees should be cut rather than pushed over with equipment (World Forestry Center and Morgan, 1993). Stumps can be ground if necessary.
 - o Restrict trenching in critical tree root zone areas. Consider boring under or digging a shallow trench through the roots with an air spade if trenching is unavoidable.
 - o Prevent wounds to tree trunks and limbs during the construction phase.
 - o Prohibit the installation of impervious surfaces in critical root zone areas. Where road or sidewalk surfaces are needed under a tree canopy, non-mortared porous pavers or flagstone (rather than concrete or asphalt) or bridging techniques should be used.
 - o Prepare tree conservation areas to better withstand the stresses of the construction phase by watering, fertilizing, pruning, and mulching around them well in advance of construction activities.

4.2 Reforestation

Soil and vegetation protection areas that have been disturbed and do not have vegetation of sufficient size, quantity, and quality to achieve the necessary coverage may require soil enhancement and replanting with native trees and vegetation in order to achieve the full hydrologic benefits of the site (see Section 6.2: Amending Construction Site Soils for soil guidelines). Consult with a qualified urban forester or landscape architect to develop a long-term vegetation and soil management plan.

4.2.1 Existing Plant Evaluation and Site Preparation

Trees remaining in the protection area should have the following characteristics:

- No major pest or pathological problems.
- No extensive crown damage.
- No weakly attached co-dominant trunks if located in areas where failure could cause damage or safety problems.
- Relatively sound trunks without extensive decay or damage.
- Wind-firm in the post development condition.

(Matheny and Clark, 1998).

Trees identified as having significant wildlife value such as snags and nesting sites should be retained regardless of the health of the tree, unless the tree poses an imminent safety threat as determined by a qualified arborist or urban forester (Pierce County Ordinance No 2003-66, 18H.40.040, Tree Conservation Standards).

Intensive inventories and individual tree health evaluation is generally limited to areas where trees can damage existing or proposed structures. Depending on the physical setting, regulatory requirements, aesthetics, and other specific management needs, inventories and subsequent evaluations may be necessary in portions or all of the protection area's interior. If inventories and management plans indicate deficiencies in protected area vegetation structure, removing unhealthy trees may be desirable to free growing space, encourage new seedlings and create age and species diversity. The site should be prepared for planting by removing invasive species, stabilizing erosion areas, and enhancing soil with compost amendment where necessary.

4.2.2 Plant Selection

The native vegetation species should be selected based on the underlying soils and the historic, native indigenous plant community type for the site (Pierce County Ordinance No 2003-66, Exhibit B, Chapter 10, Low Impact Development). Coniferous trees provide greater interception, storage, and evaporation potential in the wet months and should be the major component of the protection area if ecologically compatible with the site. A single species of vegetation should not be used for replacement purposes.

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The following general guidelines are recommended for installing a self-sustaining native plant community that is compatible with the site and minimizes long-term maintenance requirements:

- The plantings should provide a multilayer canopy structure of large trees, small trees, and shrubs.
- Emphasize climax species, for example Douglas fir (*psuedotsuga menziesii*), on drier sites with more sun exposure, and western red cedar (*thuja plicata*),

western hemlock (*tsuga heterophylla*), or sitka spruce (*picea sitchensis*) on wetter sites with less sun exposure.

- For many sites, a ratio of 2 evergreens to 1 deciduous tree will provide a mix similar to native forests.
- To create a multilayer canopy, install 50 percent large structure trees to 50 percent small trees and shrubs.
- Space large trees at 15 to 20 feet and shrubs at 4 feet on center.
- The installation should be designed to develop to a dense closed canopy (when compatible with the site) to provide interception and evaporation of precipitation in the wet months and shade the site to exclude invasive vegetation species.

(Personal communication, Bill Barnes August, 2004)

Plants should conform to the standards of the current edition of *American Standard for Nursery Stock* as approved by the American Standards Institute, Inc. All plant grades should be those established in the current edition of *American Standards for Nursery Stock* (current edition: ANSI Z60.1-2004). All plant materials for installation should:

- Have normal, well-developed branches and a vigorous root system.
- Be healthy and free from physical defects, diseases, and insect pests.
- Not have weakly attached co-dominant trunks.

4.2.3 Plant Size

Selecting the optimum size of plant material for installation includes several factors. In general, small plant material requires less careful handling, less initial irrigation, experiences less transplant shock, is less expensive, adapts more quickly to a site, and transplants more successfully than larger material (Sound Native Plants, 2000). Smaller plant material is, however, more easily overgrown by weeds and invasive species such as reed canary grass, is more susceptible to browse damage, and is more easily damaged by maintenance personnel or landowners (Kantz, 2002). Accordingly, the following recommendations are provided:

- Where invasive species are not well established, weeds and browsing are controlled regularly, and maintenance personnel and landowners are trained in proper maintenance procedures, smaller material will likely have a lower mortality rate, is less expensive, and is recommended. Small trees and shrubs are generally supplied in pots of 3 gallons or less.
- Where invasive species are prevalent and weed and browse control is not ensured, larger plant material is recommended. Larger plants will require additional watering during the establishment period.
- For larger tree stock, coniferous and broadleaf evergreen material should be a minimum of 3 feet in height and deciduous trees should have a minimum caliper size of 1 inch (Kantz, 2002).

Native species should be used for vegetation and soil protection areas not adjacent to residential lots or commercial development. Depending on aesthetic needs, cultivars adapted to the region for hardiness may be used in transition areas between protection areas and structures. For growth characteristics and site suitability of trees and shrubs native or adapted to the Pacific Northwest see Appendix 1: Street Trees and Appendix 3: Bioretention Area Plants.

4.2.4 Reference Documents for Planting

Vegetation restoration/planting methods should conform to published standards. The following guidance documents are examples:

- *Restoring the Watershed: A Citizen's Guide to Riparian Restoration in Western Washington*, Washington Department of Fish and Wildlife, 1995.
- *Plant It Right Restoring Our Streams*, Washington State University Extension <http://wawater.wsu.edu>
- *Integrated Streambank Protection Guidelines*, Washington Department of Fish and Wildlife, 2000.
- *Surface Water and Groundwater on Coastal Bluffs: A Guide for Puget Sound Property Owners*, Washington Department of Ecology, Shorelands and Coastal Zone Management Program Publication No. 95-107, 1995.
- *Vegetation Management: A Guide for Puget Sound Bluff Property Owners*, Washington Department of Ecology, Shorelands and Coastal Zone Management Program Publication No. 93-31, 1993.
- *Relative Success of Transplanted/Outplanted Plants*, Sound Native Plants, 2000.

Plants installed in the fall generally outperform late winter or spring plantings. In fall, the soil is warmer and more aerated than in the spring and transpiration requirements are less than in the spring and summer months. During the fall and winter, plants can develop sufficient root systems, recover from transplant shock, and prepare for the top growth and water demands of the growing season (Sound Native Plants, 2000).

4.3 Maintenance

In a low impact development, native vegetation and soil protection areas serve as stormwater management facilities. Clearly written management plans and protection mechanisms are necessary for maintaining the benefits of these areas over time. Some mechanisms for protection include dedicated tracts, conservation and utility easements, transfer to local land trusts (large areas), and homeowner association covenants. Property owner education should be part of all these strategies.

Ongoing maintenance should include weeding, watering, erosion and sediment control, and replacement of dead plant material for a minimum of three years from installation in order to achieve a minimum 80 percent survival of all plantings. If during the three-year period survival of planted vegetation falls below 80 percent, additional vegetation should be installed to achieve the required survival percentage.

Additionally, the likely cause of the plant mortality should be determined (often poor soils and compaction) and corrected. If it is determined that the original plant choices are not well suited to site conditions, these plants should be replaced with plant species better suited to the site.

Permanent signs should be installed explaining the purpose of the area, the importance of vegetation and soils for managing stormwater, and that removal of trees or vegetation and compaction of soil is prohibited within the protected area. Permanent fencing, rock barriers, bollards or other access restriction at select locations or around the perimeter of protection areas may be required to limit encroachment.

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